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Utility approaches to evaluating the effectiveness of consumer confidence reports

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ABSTRACT

The Safe Drinking Water Act Amendments of 1996 require community water systems in the United States to send consumers Consumer Confidence Reports (CCRs). CCRs contain information on detected contaminants and required educational information about drinking water. The authors of this study developed a survey to evaluate how utilities track consumer feedback, understanding, and the role of the CCR in shaping consumer perceptions about water quality. Responses from this survey indicate it is common for utilities to indirectly track the effectiveness of their CCRs, but few utilities indicated directly evaluating consumer understanding or the effect of CCRs on consumer perceptions.

1. Background

A consumer confidence report (CCR) is required to be prepared annually by most community water systems (CWS) under the 1996 amendments to the U.S. federal Safe Drinking Water Act (SDWA, PL 104–82). The purpose of the report, which is often referred to as a water quality report, is to provide information to consumers and enable them to make health-based decisions regarding drinking water consumption. The CCR serves as a public right-to-know provision of the SDWA (USEPA, 1998).

Under the CCR rule, CWSs with at least 15 service connections or serving more than 25 consumers year-round must provide an annual report for customers that includes information on the quality and safety of their drinking water. Unless the CWS has a waiver, CWSs must directly deliver the report to customers. The report must include:

1. Water system information
2. Information on the source of water
3. Required definitions
4. A table summarizing detected contaminants
5. Information on monitoring for *Cryptosporidium*, radon, and other contaminants
6. Compliance with other drinking water regulations
7. Variance and exemptions if applicable and
8. Required educational information.

Required educational information includes statements about contaminants in all drinking water, information to vulnerable populations about *Cryptosporidium*, and statements on nitrate, arsenic, and lead if applicable (USEPA, 1998). CWSs are required to distribute the CCR to consumers and a copy to their primacy agency by July 1 of each year and, within three months after the report is due, provide certification to their primacy agency that the report has been sent to consumers and contains correct information (USEPA, 1998).

2. CCR effectiveness

Before the development and first distribution of the final CCR rule, researchers began to evaluate the effectiveness of components that would go into CCRs, including whether the pilot versions of the report affected consumers' confidence in the safety of their drinking water. Trax and Snyder (1998) conducted a questionnaire that evaluated consumers' overall understanding of a pilot CCR and found that 62–86% of customers remembered receiving the CCR. Those who recalled receiving the CCR, however, did not recall most important information, as determined by the CCR rule guidelines, such as contact information, source of the water, water quality contaminant levels, and the meanings of key terms, such as maximum contaminant level (MCL) and maximum contaminant level goal (MCLG). Importantly, the authors considered important information to be that which is required by the CCR rule, and the CCR rule does not require summary statements on whether water

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quality meets standards or other condensed information consumers may find more helpful. Trax and Snyder (1998) concluded it was possible there was an overload of information in the CCR.

In another evaluation of the report's effectiveness, one water utility in Connecticut voluntarily created and delivered a pilot CCR in 1997 and conducted pre- and post-report surveys on consumer response, finding that consumer confidence in water quality increased 2.4% (Odugbesan et al., 1998). Roper Starch (1999)conducted a nationwide survey to determine what information consumers already knew and what they wanted to know about drinking water. The study found that Americans wanted to know more about the quality of their drinking water than they already knew and that 75% of the survey respondents indicated that they "sometimes" or "always" read information regarding drinking water they received from their utility (Roper Starch, 1999). During the development of their first CCR, the District of Columbia Water and Sewer Authority (now DC Water) conducted focus groups to evaluate and improve the report (Spiesman et al., 2002). They found that the most useful practices for their CCR would be to include simple, large graphics and summary statements in larger font for those consumers who did not want detailed information (Spiesman et al., 2002).

Researchers continued to evaluate the effectiveness of the consumer confidence reports in the initial years after the rule. After the fourth year of utilities sending the CCR, Benson et al. (2002)conducted surveys with 89 CWSs in Nevada that evaluated consumer response, costs versus benefits of the CCR, and effectiveness of the CCR in informing consumers about water quality. The study found that there was a slight increase in consumer inquiries after distribution of the CCR. At that time, 39% of utility respondents indicated they believed the benefits to consumers of the CCR outweighed the costs. When asked whether they believed benefits to consumers would continue to outweigh costs in the future, 51% of respondents indicated that they believed so. Further, 61% of utility respondents indicated that they felt the CCR was an effective tool to inform consumers about the source and quality of their drinking water (Benson et al., 2002). Johnson (2003) aimed to evaluate the effects of format and presentation of contaminant information on consumer perceptions about their water quality. The study found that whether CCRs included qualitative descriptions of contaminant levels, numerical contaminant levels in a table, or a bold statement indicating a violation had occurred did not change overall consumer opinion on water quality and utility performance (Johnson, 2003). The author did find that qualitative reports performed the worst at communicating violation information and that consumers who viewed reports with bolded violation statements were more likely to indicate a violation had occurred (Johnson, 2003).

2.1. Challenges of the CCR: readership and recall

Researchers have studied the readership of the CCR. In 2002, the EPA conducted a survey of 1000 households that included questions on the CCR, finding that only 29% of respondents indicated they had read their CCR and an additional 8% recalled receiving the CCR (USEPA, 2003). The survey found that 71% of respondents were either confident or very confident about the quality and safety of their tap water and over 90% indicated they would like more information about possible contaminants in their water (USEPA, 2003). Lazo et al. (2004) evaluated how CCRs influenced consumer perceptions and found that only 40% of consumer respondents remembered receiving a water quality report. Of those who remembered receiving a CCR, over 40% felt more confident in their water quality. The authors estimated that about 35% of all customer households read their utility's CCR (Lazo et al., 2004).

In a more recent evaluation of CCR effectiveness, the Las Vegas Valley Water District evaluated the effects of primer mailing formats on customer recall the CCR. In this study, primer mailing pieces were letters or postcards sent to customers indicating the Consumer Confidence Report would be delivered in the near future. The authors found recall of the CCR was higher among individuals who remembered receiving any primer over individuals who did not remember receiving a primer at all. The study also found any recall about the CCR improved consumer ratings on drinking water safety (Davis, 2007), indicating that recall of any primer piece shaped consumer perception of drinking water. Similarly, Carpenter and Roberson (2013) conducted a series of utility and consumer surveys assessing recall and opinions on various portions of the CCR. In one of their surveys, the authors assessed consumer knowledge about CCRs, and 49.5% of respondents recalled receiving one either in the past year or sometime in the last three years. Of those who recalled receiving a CCR, between 65% and 93% somewhat or strongly agreed that the report contained important information and increased their confidence in their water supply (Carpenter and Roberson, 2013).

2.2. Challenges of the CCR: complex, technical language and mandated information

Community water systems are required to include definitions and other information with language that is suggested or mandated by the EPA or state's primacy agency (USEPA, 1998). The nature of this language required in the CCR began as and has continued to be a source of concern for many CWSs (Berberich, 1998). Johnson (2001) evaluated public reaction to the language required by the CCR rule, finding that the majority of respondents understood the mandated language but expressed concern about water quality after reading it (Johnson, 2001). Rudd, Kaphingst, Colton, Gregoire, and Hyde (2010) aimed to rewrite a utility's CCR in plain language. The authors assessed, restructured, and rewrote a utility's CCR, focusing on simple vocabulary and sentence structure and length. The utility responsible for sending the CCR adopted some of the researchers' recommended changes but were limited by the increase in report length, associated costs, and mandated language (Rudd et al., 2010).

Researchers have continued to evaluate the effects of the required language on consumer confidence in water quality and how CWSs can improve their communication. Phetxumphou et al. (2016) evaluated the understandability of a sample of CCRs and found that many of the CCRs failed to effectively communicate drinking water information. The researchers trained individuals to rate a sample of CCRs using the Centers for Disease Control and Prevention's Clear Communication Index (CCI) indices and found that none of the CCRs received "passing" CCI Index scores (CDC, 2015). Using the CCI Index score as a measurement of effective public health communication, the authors concluded that CWSs were not effectively communicating water quality information to customers and that summary statements might be useful (Phetxumphou et al., 2016).

In another study, the same group of researchers evaluated the readability of a nationally representative sample of CCRs using Flesch-Kincaid readability tests (Roy et al., 2015). Flesh-Kincaid readability tests use measures of word and sentence length to assess how difficult a passage is to understand based on U.S.-grade reading levels. Flesh-Kincaid tests are common in education, publishing, healthcare, and industry for written forms of communication (Kincaid et al., 1975). The authors found that the CCRs were written at the 11th to 14th-grade level, while the National Institute of Health recommends public health communications be written at a 6th or 7th-grade level, with shorter sentences and less word complexity (Roy et al., 2015). The authors urged utilities to consider adjusting the Flesch-Kincaid reading level of their CCRs to increase their effectiveness (Phetxumphou et al., 2017).

3. Recent analysis and anticipated changes to the CCR

The regulatory driver and structure underlying the CCR have been largely unchanged since the CCR rule was finalized in 1998. However, the CCR rule and its implementation have been the subject of regulatory review by the U.S. EPA in recent years. In 2011, U.S. EPA announced

that a retrospective review of the CCR rule would be conducted as part of the Obama Administration's Executive Order 13563 (76 FR 3821, 2011). One EPA official described the review as an opportunity to increase consumer awareness of water quality through consideration of new CCR methods (Eisenberg, 2011). In 2012, the EPA released a summary of the retrospective review, which included coverage of CCR understandability and consideration of electronic delivery of CCRs (USEPA, 2012). According to public feedback submitted to the EPA during the review process, information in the CCR could be confusing, misleading, and alarming, especially the detected contaminants tables and health effects language. The public stakeholders involved in the understandability portion of the retrospective review suggested that the EPA update and strengthen guidance and templates (USEPA, 2012).

As part of the retrospective review, EPA considered the potential merits and drawbacks of electronic delivery of the CCR. Stakeholders also believed that printing and mailing the CCR was unnecessarily expensive, technological and regulatory concerns could inhibit electronic delivery, and overcoming those concerns to allow for electronic delivery would provide multiple benefits to consumers (USEPA, 2012). After the retrospective review, U.S. EPA released a memorandum (USEPA, 2013b) detailing five electronic delivery options that would fulfill the CCR rule's requirement for reports to be “mailed or otherwise directly delivered” (USEPA, 1998). The electronic delivery methods include a CCR embedded in an email message, a CCR sent as an attachment to an email, URL linked directly to the CCR sent via email, a URL linked directly to the CCR mailed to customers (e.g., via a water bill or a separate mailing), or any additional electronic delivery method that met the definition of direct delivery (USEPA, 2013b). As part of an evaluation of possible benefits of electronic delivery, Carpenter and Roberson (2013) conducted two surveys with CWSs and one public survey and found that electronic delivery of the CCR could result in nearly $20 million in cost savings annually to utilities.

4. Anticipated changes from America's Water Infrastructure Act of 2018

America's Water Infrastructure Act (AWIA) of 2018 (S. 3021, Public Law 115–270) was signed into law on October 23, 2018. This law makes many changes across various portions of the Safe Drinking Water Act. Section 2008makes changes to the Consumer Confidence Report, for which EPA will need to develop regulations by October 2020. These changes include:

- Utilities with greater than 10,000 population served will need to provide CCRs at least twice per year
- The option for electronic delivery is now codified in the law, rather than an interpretation of previous law
- Increasing the “readability, clarity, and understandability” and “accuracy” of the information within the CCR
- Including information about corrosion control efforts as part of the required elements of the CCR.

Given these changes, additional information about the current utilization of CCRs as a communications tool will be increasingly important for policymakers and utilities to consider.

5. CCR as a communications tool beyond required information

A roundtable of utility officials gathered by the American Water Works Association met in 1997 when the CCR rule was still in development to discuss challenges and benefits of the upcoming rule. In addition to concerns about the health effects language, participants noted that the CCR could be utilized as an annual report on water quality and an opportunity to make consumers more comfortable with their water source (Berberich, 1998). Many authors have since conducted studies with suggestions on how to increase the effectiveness or type of information included in CCRs (Meyer-Emerick, 2004; Phetxumphou et al., 2017; Spiesman et al., 2002). USEPA provides the CCR iWriter tool and reference sheets for utilities to consult when creating their CCRs (USEPA, 2009, 2015). In these reference sheets, U.S. EPA often emphasizes the role of the CCR to inform customers about other issues, such as source water protection or water conservation methods (USEPA, 2009).

Despite the CCR's potential, few researchers have comprehensively examined the CCR as an instrument to engage with customers, provide meaningful information, and develop a process of continuous improvement based on feedback. This study explores how utilities track CCR effectiveness and utilize the CCR as a communications tool. The results of the survey may provide a baseline assessment as well as research and policy options for future consideration.

6. Survey methods

In light of concerns among U.S. consumers about the quality of drinking water (AP-GfK, 2016; Chapman University, 2017; DiJulio et al., 2016; Firth et al., 2016; McCarthy, 2016, 2017) and continuing issues with the effectiveness of CCRs (Phetxumphou et al., 2016; Roy et al., 2015), community water systems face challenges in increasing consumers' confidence in their drinking water. This survey was developed to understand how U.S. utilities track consumer engagement, understanding, and the role of their CCR in shaping consumer perceptions about water quality. The survey also aimed to identify common areas of consumer misunderstanding and evaluate what methods utilities are using to increase the effectiveness of their CCR.

The survey was conducted from June 25, 2018 through July 23, 2018 and distributed to the American Water Works Association's (AWWA's) approximately 4000 member utilities in the U.S. states and territories. A reminder message was sent out approximately one week before the survey closed. The following categories of questions were included in the survey:

- Information about the utility, including utility name, state, and population served. Some of this information has been anonymized as the survey was conducted with the agreement that individual responses would not be identified. The ownership of the utility was not ascertained.
- Information about how the utility tracks engagement and understanding of the CCR
- Information about how the utility tracks consumer confidence in water quality and the effect of the CCR on consumer confidence in water quality
- Information about how the utility assesses what information consumers would like in the CCR and ways the utility makes changes to increase engagement.
- Methods the utility uses to conduct outreach regarding the CCR, including information provided on the utility's website
- Whether the utility has used or is planning to use electronic delivery. For those utilities that have, whether they've changed or added information that could not be included before due to space, weight, or other limitations, and whether any testing on the impact of electronic delivery has been completed
- Information about feedback received from customers about the CCR
- Information about any specific challenges in CCR required language
- Any supplemental information included in the CCR to increase engagement
- Whether the utility updates water quality information more than once per year through mail or electronic delivery
- Challenges the utility would face with a requirement to send more than one CCR per year

The sampling method utilized has both strengths and weaknesses. The use of AWWA's members allows for wide distribution of the survey

and reaches many large water utilities but is nonrandom and does not represent non-member utilities. This wide reach can be seen in that the respondents collectively serve a population of over 48.2 million people. With approximately 86% of the U.S. population of 327 million served by public water systems (281 million), this sample contains the information of approximately 15% of the U.S. population served by community water systems. Since the main intent of this study is to understand the breadth and depth of techniques used to engage customers with the CCRs, this method accomplished reaching a large portion of the total possible study population. However, as the sample pool contains very few small and very small (< 3300 and < 500 population served) utilities, it does not represent the practices undertaken by those utilities, which account for most of the nation's water utilities but a relatively small percentage of the population served by public water suppliers. The survey asked only for information about institutional practices and did not ask for the opinions of or information about the individuals completing the survey. The survey is therefore not considered human subjects research. To maximize response rates, utilities were not asked to provide examples or data in response to survey questions, such as questions about supplemental information included in the CCR or regarding how utilities track consumer engagement of the CCR.

7. Survey results and discussion

The online survey consisted of a total of 20 questions; three were open-ended and 17 were multiple choice. A total of 240 respondents completed the survey. To maximize the number of responses, survey respondents were able to skip questions. As a result, each question in the survey did not receive an equal number of responses. Survey results were obtained from utilities in 43 U.S. states (excluding Alaska, Idaho, Mississippi, Montana, Nebraska, Rhode Island, Vermont as well as the District of Columbia). Responses were received from utilities in Guam and Puerto Rico. Because the CCR is a regulatory construct unique to the United States, responses were not solicited from other countries. To minimize the number of questions, the survey did not include questions about variation in CCR methods and community water system ownership.

Table 1 shows the distribution of responses to this survey by utility size. Utility sizes were based on those designated in the final CCR Rule (USEPA, 1998). Notably, the distribution of utility sizes represented in the survey differs from the distribution of utility sizes in the United States (Table 2). When viewed by number of utilities, community water systems in the United States are overwhelmingly very small (< 500 population served) or small (501–3300 population served). We recognize the applicability of these results to very-small and small systems is limited. Although a nonrandom and not representative sample, the respondents report that they collectively serve more than 48 million, which is a considerable portion of the U.S. population served by community water systems. The respondents also represent a higher proportion of large (utilities serving between 10,000 and 100,000 people) and very large (utilities serving more than 100,000 people) utilities operating in the United States. This distribution of utilities is reasonable for our purposes given that large and very large utilities provide water for 82% of the US population served by public water systems (USEPA, 2013a).

Table 1
Distribution of survey responses by utility population served.

Utility Population Size Category	Number of System Respondents	% Respondents[a]	Population Served	% of U.S. Population Served
25–500	2	1%	621	> 1%
501-3300	34	14%	61,249	> 1%
3301–10,000	32	13%	206,422	> 1%
10,001–100,000	102	43%	4,397,435	1.4%
> 100,000	69	29%	43,606,602	14.1%
Total	239	100%	48,272,529	15.6%

[a] Remaining respondent (1) is a wholesaler that does not provide the CCR in full directly to customers.

Table 2
Distribution of U.S. Utility sizes by population served.

Utility Population Size Category	Number of Systems	% of Systems	U.S. Population Served	% of U.S. Population Served
25–500	28,346	55%	4,763,672	2%
501-3300	13,737	27%	19,661,787	7%
3301–10,000	4936	10%	28,737,564	10%
10,001–100,000	3802	7%	108,770,014	36%
> 100,000	419	1%	137,283,104	46%

Source: US EPA. (2013a). Fiscal Year 2011Drinking Water and Ground Water Statistics (EPA 816-R-13-003).

8. Tracking CCR effectiveness

For the purposes of this study, CCR effectiveness includes whether a CCR drives consumer engagement, is understandable to consumers, or affects consumer confidence in their water. Survey respondents were asked to describe what methods their utility uses to track consumer engagement and understanding of the CCR. As shown in Table 3, 45% of utility respondents indicated they use at least one method of tracking consumer engagement or understanding of the CCR; 22% of utility respondents indicated they use two or more methods. Of the utilities that used an “other” method, 10 indicated that they track consumer engagement with the CCR using website analytics. With mail delivery of the CCR, utilities would need to perform surveys or other methods to estimate the readership of their CCR. With electronic delivery, utilities that are able to track the number of times the report has been accessed relatively easily.

Utilities were asked what methods they use to evaluate consumer perceptions about water quality. Less than two percent of respondents indicated they evaluate the effect of the CCR on shaping consumer confidence in water quality. Thirteen percent of respondents indicated they conduct consumer surveys evaluating consumer confidence in their water quality generally, and 11% of respondents indicated they conduct consumer surveys evaluating specific consumer concerns about water quality. Fifteen percent of respondents selected “other” as a method of evaluating consumer confidence. Sixty-eight percent of respondents indicated they do not track consumer perceptions about water quality. In turn, roughly one-third of the utilities surveyed conducted at least one method of tracking consumer perceptions about their water quality. These findings indicate that few of the utilities surveyed evaluate whether their CCR has an effect on consumer confidence.

Meyer-Emerick (2004) noted CCRs might not address consumer concerns if the utilities are not aware of what information consumers

Table 3
Utilities’ methods used to track consumer engagement or understanding of the CCR.

Method	Responses *number*	Responses %[a]
Record the number of inquiries or comments	84	35%
Record the content of inquiries or comments	57	24%
Conduct consumer surveys or other methods	12	5%
Other	27	11%
Do not track	131	55%
Total number of respondents	238	

[a] Percentages do not add up to 100% because utilities may use more than one method to track consumer engagement or understanding.

want to know. Our survey, therefore, asked what methods utilities use to identify information consumers would like in their CCRs. Fewer than 2% indicated they conduct surveys or polls that directly ask consumers what information they would like to see in their CCR. Fifty-one percent of respondents indicated they address past questions or concerns from consumers with regard to CCR information. This finding suggests that more than half of the survey respondents have altered or considered altering their CCR based on feedback from consumers. Nine percent of respondents selected "other" as a response, which included methods such as website analytics, social media, and tracking requests for paper copies. Forty-six percent of respondents indicated they do not use any methods to understand what information consumers would like in their CCRs, pointing to an opportunity for engagement.

The format and language of the CCR have been sources of concern for both utilities (Berberich, 1998) and researchers in the area of public health communication (Phetxumphou et al., 2016; Roy et al., 2015; Rudd et al., 2010). Section 1414(c)(4)(B) of the Safe Drinking Water Act lays out the specific requirements for the content of the CCR, including some format and language requirements that cannot be altered (USEPA, 1998). However, under the CCR rule, CWSs are able to add information that is deemed appropriate for public education and may change the format of most CCR information. Utilities were asked what methods they use to change or test differences in CCR language or format to increase consumer engagement or understanding of the content. As shown in Table 4, 44% of respondents perform at least one method of changing or conducting testing on format or language; 29% of respondents perform two or more methods.

Respondents were also asked to indicate methods used to conduct CCR outreach. Forty-four percent of respondents indicated that they provide an electronic or hardcopy newsletter to consumers; 34% indicated that they give announcements to local media outlets; 80% indicated that information about the CCR is available on the utility website; and 45% respondents indicated that they advertise the CCR on social media. Only 16% of respondents indicated that they do not conduct any CCR outreach. Overall, 83% of respondents perform at least one method of outreach, and 68% of respondents perform two or more methods of outreach. This survey did not specify whether outreach efforts included acceptable electronic delivery methods (USEPA, 2013b) or were required by the utility's primacy agency, so it is possible that some responses reflect their primacy agency's requirements for meeting good faith efforts to reach non-bill paying customers.

9. Variations in methods of tracking and increasing consumer engagement, understanding, and perceptions

In total, 81% of utilities responding to this survey perform at least one method of tracking or evaluating consumer feedback, understanding, or perceptions about water quality based on the CCR. Nineteen percent of the respondents did not track CCR engagement or perceptions, did not evaluate what information consumers would like in their CCR, and did not test or make changes to the language or format of the CCR.

Table 4
Utilities' methods for changing or testing differences in CCR language or format.

Method	Responses *number*	Responses %[a]
Change language/wording where applicable	85	36%
Change format of information	66	28%
Change format of figures or pictures	61	26%
Change the amount or type of information	59	25%
Conduct testing on differences in at least one of these aspects	2	1%
Other	13	5%
Do not change or test	132	56%
Total number of respondents	237	

[a] Percentages do not add up to 100% because utilities may use more than one method of changing language or format aspects of their CCR.

Fig. 1 shows the utilities' methods of tracking and increasing consumer engagement, understanding, and perceptions by utility size. Using independent samples Kruskal-Wallis Tests with a significance level of 0.05, the distribution of all five methods varied across system size. $P < 0.001$ was found for four of these categories, with $P = 0.002$ for tracking of consumer perceptions. The distribution of these variables is visualized in Table 1. Because the survey yielded so few responses from CWSs serving populations of fewer than 500 people, results from systems of this size were not included in the analysis.

Overall, larger utilities were more likely to indicate they perform at least one method of tracking consumer engagement, understanding, or perceptions about water quality, changing CCR language or format, evaluating what consumers want in their CCR, or advertising their CCR. Utilities of medium size (serving between 3301 and 10,000 people), had the fewest respondents that indicated they conducted at least one method of evaluating and increasing consumer engagement, understanding, and perceptions.

Fig. 2 shows methods of tracking and increasing consumer engagement, understanding, and perceptions by US Census Bureau Region. Using independent samples Kruskal-Wallis Tesst with a significance level of 0.05, the distribution of three of five methods varied across regions, although with considerably less certainty than across system size. Significance values were $p = 0.004$ for the distribution of conducting publicity, $p = 0.013$ for whether or not utilities tracked consumer perceptions, and $p = 0.039$ for testing or changing aspects of the CCR language or format.

9.1. Electronic delivery and CCR effectiveness

In a 2012 survey, Carpenter and Roberson (2013) assessed the feasibility and potential cost savings and other benefits associated with electronic delivery of CCRs. Following the same methods as this survey, Carpenter and Roberson (2013) distributed their survey to the approximately 4000 American Water Works Association utility members in the U.S. states and territories. The 713 utility respondents to the Carpenter and Roberson (2013) survey served a smaller average population size of 25.5 million people, compared to this survey's average of 48.2 million people served.

Utilities were asked whether their utility had used electronic delivery for some or all of their consumer confidence reports (Table 5). Notably, 70% of respondents indicated they have delivered their CCR electronically, compared to up to 93% of respondents indicating in 2012 that they would use electronic delivery (Carpenter and Roberson, 2013). Respondents that indicated they currently or have sent the CCR electronically were asked if their utility had added information or changed aspects of the CCR that were not included in years when the CCR was delivered on paper. Fifty-seven percent of respondents indicated they had not added more information and did not plan to; 13% responded that they had not added information or changed aspects of the CCR but planned to; and 32% of respondents indicated they had added or changed aspects of the CCR since changing to electronic delivery. Table 6 shows a summary of the information or altered aspects of the CCR. Importantly, the majority of changes included the addition of more or clarifying information on water quality not required by the CCR.

Respondents were also asked if their utility had tracked or conducted testing on whether electronic delivery of the CCR had changed consumer feedback, understanding, or perceptions of water quality based on the CCR. Twenty-four percent responded that they have tracked the number of times the report has been accessed; 4% indicated they had conducted consumer surveys; and 5% of respondents selected "other." Sixty-nine percent of utilities responded they have not tracked the effects of electronic delivery of the CCR on consumer engagement,

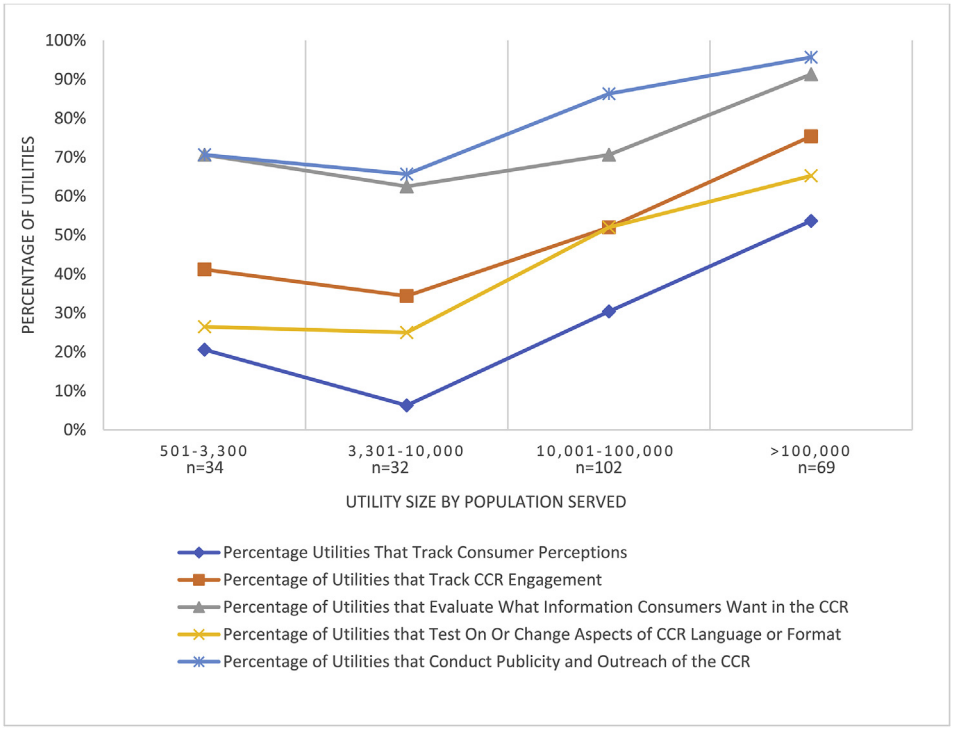

Fig. 1. Utilities' methods of tracking and increasing consumer engagement, understanding, and perceptions of the CCR by utility size.

understanding, or confidence in water quality.

A literature review did not reveal published research evaluating the differences in readership or effectiveness of CCRs delivered by mail or electronically. There may be variation in CCR readership based on acceptable methods of electronic delivery, such as a URL included in the hard-copy or electronic bill. As noted, electronic delivery introduces the potential for utilities to examine CCR readership through website analytics, such as click-through rates or page views.

9.2. Cost savings of electronic delivery of the CCR

In their 2012 utility survey, Carpenter and Roberson (2013) asked utilities whether they expected to use electronic delivery and whether it was expected to reduce costs. The estimated nationwide cost of implementing the CCR rule through mail delivery was $28 million in 2012 dollars. An upper bound estimate of current cost savings by utilities can be produced through the following calculation: Total pre-electronic

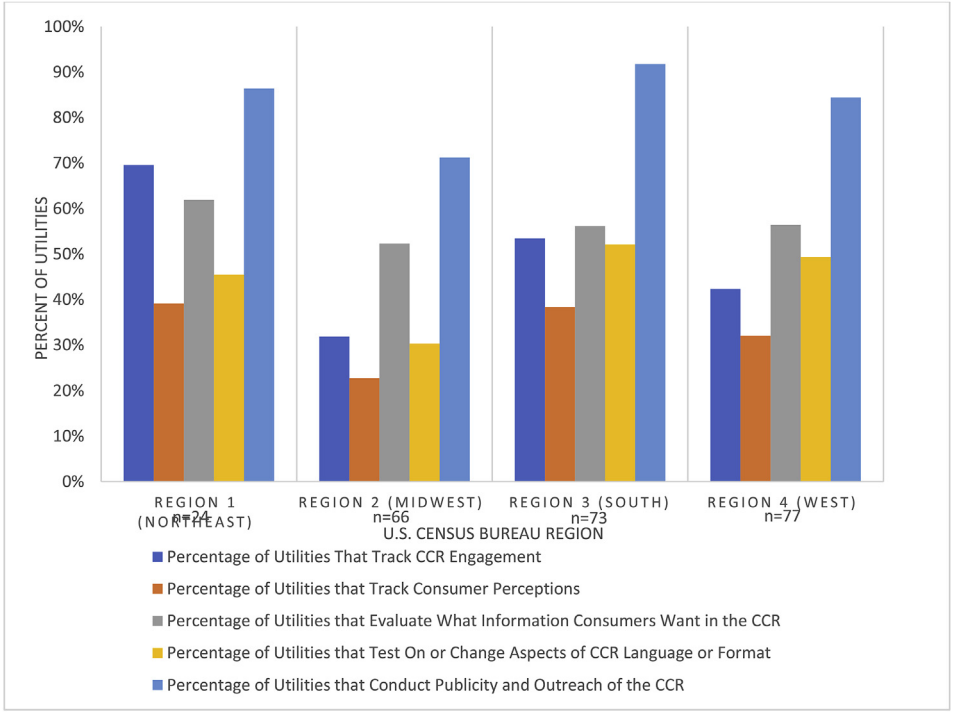

Fig. 2. Utilities' methods of tracking and increasing consumer engagement, understanding, and perceptions of the CCR by US census region.

Table 5
Utilities' delivery methods of the CCR.

Use of electronic delivery	Responses number	Responses %
Have used electronic delivery	168	70%
Had used electronic delivery and have since stopped	5	2%
Have not used electronic delivery but plan to	26	11%
Have not used electronic delivery and do not plan to	40	17%

Table 6
Additions and changes utilities have made to CCRs since changing to electronic delivery.

Change Made	Responses *number*
Provided More Information	43
More pictures	14
Overall More Visually Appealing	10
Other	8
Total Number of Utilities That Indicated They Have Made Changes Due to Electronic Delivery	53

delivery CCR costs *multiplied by* average percentage of estimated cost savings for "Bill providing URL" methodology *multiplied by* the percentage of utilities currently using electronic delivery *equals* the upper bound of current electronic delivery annual cost savings.

For comparability, all values shown in Tables 7 and 8 are shown in both 2012 and 2018 dollars (adjusting using the Bureau of Labor Statistics Calculator for January). Table 7 shows this upper bound cost savings based on the utilities *currently* using electronic delivery of the CCR.

Considering all utilities that use or plan to use electronic delivery, the upper bound potential savings can be identified, as shown in Table 8.

A bill providing URL delivery method likely adds the least or no additional cost to a utility since a URL adds little additional text to a bill delivered by mail or electronically. Other delivery methods, such as a mailed postcard with the CCR URL, introduce more costs given printing and mailing costs. This upper bound savings estimate does not take into consideration variation in utilities' electronic delivery methods.

Carpenter and Roberson (2013) upper-bound savings estimate for electronic delivery of the CCR was $19.5 million (2012 dollars) or $21.5 million (2018 dollars). The savings estimate based on information gathered in this survey is about 24% lower when considering only utilities already using electronic delivery (Table 7) or 12.5% lower when including utilities that may implement it in the future (Table 8). The lower upper bound savings estimate can be attributed to the lower percentage of utilities that have implemented or are expecting to implement electronic delivery than was previously estimated.

10. Consumer feedback of the CCR

Utilities were asked what common consumer misunderstandings they encountered after sending the CCR. Overall, 38% indicated that they do not hear misunderstandings from consumers, suggesting that slightly less than half of utilities encountered no misunderstandings. Thirty-nine percent indicated consumers experience difficulty interpreting whether levels of detected contaminants are a concern, which was a pattern found by Johnson (2003). Twenty-one percent of respondents indicated consumers had difficulty interpreting whether information in required statements is applicable to them; 32% indicated that they encounter consumers misunderstanding that tested contaminants not listed in the report are not detected.

Table 9 shows a summary of utilities' responses to CCR requirements that make it more difficult for them to communicate to consumers. Some of those requirements were the same as those noted in prior literature, such as required definitions (Trax and Snyder, 1998) and health effects of contaminants (Berberich, 1998). In total, 53% of respondents reported that there was at least one aspect of the CCR requirements that made it more difficult for them to communicate; 36% indicated there were two or more aspects.

Utilities were asked to describe the feedback they received from consumers regarding the CCR. Thirty-eight percent of respondents indicated they received positive feedback from consumers. The highest recorded response was a request for a copy of the CCR (58%), indicating some consumers may have lost their report, never received one, or wanted a hard copy. The next highest recorded response was questions or concerns about water quality after reading the report (56%), in line with consumer concerns after reading the report, as shown by Johnson (2001). Thirty-eight percent of utilities indicated consumers have questions or concerns about a water quality issue not included in the report. Twenty-one percent indicated that consumers found at least some of the report content too technical, and 13% indicated they hear "other" feedback. Only 13% of the utilities indicated they did not receive any feedback on the CCR. Utilities may not receive feedback on the CCR from consumers for a multitude of reasons: consumers may not be reading the CCR, contact information for the utility may not be easily accessible, or consumers may be satisfied with the information in the CCR.

Utilities were asked what additional (that is, not required) information they include in the CCR. Table 10 lists their responses. A large majority of respondents (83%) indicated they include at least one additional piece of information, and 75% reported including two or more additional pieces of information, indicating the majority of respondents to this survey are modifying and including information for consumers beyond CCR requirements. Notably, 64% of respondents indicated they include a summary statement about the quality of drinking water, which is consistent with the finding by Phetxumphou et al. (2016) that 63% of CCRs evaluated explicitly stated whether the water was safe to drink according to state and federal standards.

11. Utility concerns with a potential requirement to send more than one CCR annually

At the time this study was being designed, the Drinking Water System Improvement Act of 2017 (H.R. 3387) was introduced, containing provisions for improving and affecting water infrastructure and a requirement to release consumer confidence reports twice annually (H.R. 3387, 2017). To understand what challenges this would present, utilities were asked how frequently they update water quality and what

Table 7
Upper bound cost savings from current electronic delivery of CCRs.

Current electronic-delivery upper bound cost savings	2012 Dollars	2018 Dollars
Pre-electronic delivery nationwide CCR cost estimate[a]	$28,174,000	$30,809,000
Percentage estimated cost savings for "Bill providing URL" methodology[a]	75%	75%
Percentage of utilities using electronic delivery	70%	70%
Upper bound of current electronic delivery annual cost savings	$14,791,000	$16,175,000

[a] Value derived from Carpenter and Roberson (2013)..

Table 8
Upper bound cost savings from potential future electronic delivery of CCRs.

Potential electronic-delivery upper bound cost savings	2012 Dollars	2018 Dollars
Pre-electronic delivery nationwide CCR cost estimate[a]	$28,174,000	$30,809,000
Percentage estimated cost savings for "Bill providing URL" methodology[a]	75%	75%
Percentage of utilities using or considering electronic delivery	81%	81%
Upper bound of potential electronic delivery annual cost savings	$17,116,000	$18,716,000

[a] Value derived from Carpenter and Roberson (2013)..

Table 9
Required portions of CCR that make it more difficult for utilities to communicate clearly with consumers.

Required Portion of CCR	Responses *number*	Responses %[a]
Contact information	2	1%
Information on public participation opportunities	2	1%
Information about source(s) of water	11	5%
Required definitions (i.e. MCL, MCLG, TT, AL, MRDL, MRDLG)	60	26%
Detected contaminants health effects language	60	26%
Information on monitoring for *Cryptosporidium*, radon, and other contaminants (if detected)	46	20%
Compliance with other drinking water regulations	21	9%
Variance and exemptions (if applicable)	18	8%
Required educational information regarding contaminants in drinking water and bottled water	36	16%
Information to vulnerable populations about Cryptosporidium	33	15%
Statements on nitrate, arsenic, and lead (if applicable)	35	15%
Other requirements	23	10%
No requirements make it more difficult to communicate.	109	48%
Total number of respondents	227	

[a] Percentages do not add up to 100% because there are multiple requirements for the CCR.

Table 10
Additional Information Utilities Include in CCRs (i.e., not required by the rule).

Information	Responses *number*	Responses % [a]
Explanation of Treatment Process	98	43%
Diagram of Treatment Process	37	16%
A summary statement about the quality of drinking water	147	64%
Information about water conservation	99	43%
Information about costs of water treatment	13	6%
Educational information about area water issues	76	33%
Photos or other diagrams	102	44%
Other	37	16%
Do not include additional information	39	17%
Total number of respondents	230	

[a] Percentages do not add up to 100% because there are multiple requirements for the CCR.

concerns they would have if there were a requirement to send more than one CCR annually. H.R. 3387 itself did not move forward in Congress, but many of its provisions, including the requirement for biannual delivery of the CCR for CWSs serving more than 10,000 people, were ultimately incorporated into AWIA (2018).

Seventy-eight percent of respondents indicated they send only the CCR once annually as required; 14% indicated they update water quality information more than once a year through mail or electronic delivery, or a combination of methods; and 8% indicated they are considering updating information more than once annually. In total, less than a quarter of the respondents indicated that they send information more than once per year or are considering doing so. This study did not assess whether utilities prepare and make available additional and more frequent water quality information independent of the CCR framework.

Regarding problems associated with a requirement to send more than one CCR a year, 66% of respondents indicated difficulty associated with staffing needs required to create the CCR, and 65% indicated they would be concerned with costs associated with printing, mailing, and other paper delivery services. It is unclear why 65% of respondents indicated concern with paper delivery costs given that 70% of respondents indicated they use electronic delivery for CCR delivery. Fourteen percent indicated a concern about the difficulty managing inquiries after a CCR is sent, and 15% indicated concern about technical difficulties associated with billing systems and websites. Twenty-one percent of respondents selected "other" as a concern regarding a requirement to send more than one CCR annually, including that sending more than one would be wasted utility effort and a possible negative effect on public perception due to cost or confusion.

12. Summary and conclusions

This research sought to evaluate how community water systems track and evaluate the effectiveness of their consumer confidence reports. The results indicate that the majority of utilities perform indirect evaluations of the effectiveness of their CCRs, but very few indicated performing surveys or other methods to evaluate CCR effectiveness. Practices in evaluating and increasing CCR effectiveness varied by utility size and US Census Bureau region.

Almost 40% of utilities indicated receiving positive feedback about the CCR. Nearly 40% of utilities also reported hearing no misunderstandings of the report from consumers. Consistent with previous findings, more than half of the utilities reported receiving questions or concerns from consumers after reading the report (see Johnson (2001), and 38% reported receiving questions about water quality concerns not mentioned in the CCR (see Meyer-Emerick, 2004).

Utilities may have little incentive to try to improve or evaluate the effectiveness of the CCR given limited resources and the requirement to send the CCR with the required language, regardless of feedback received from consumers. However, some survey respondents reported modifying their CCR to increase consumer engagement by conducting outreach methods that are not required by the CCR rule. Other survey respondents indicated modifying the language or format of their CCR to increase the understandability of the report to consumers. Notable examples include utilities adopting a seventh-grade reading level, using feedback from citizen groups, and changing online CCR formats to more

user-friendly booklets.

Persistent utility and consumer concerns highlight the importance of additional research on CCR implementation and effectiveness. Future research can take utility size and ownership structure into account. Future research can focus on evaluating the role of electronic delivery and its capacity to add more information or make more visually appealing reports in shaping consumer knowledge of and confidence in water quality. Future research can focus on comparing the readership or recall of CCRs delivered by mail compared to those delivered electronically. Finally, future research may also focus on the impact and effectiveness of AWIA's requirement for large utilities to send a CCR at least biannually. Information gained from this study and related CCR research may aid regulators and utilities in improving readability, clarity, understandability, and accuracy of the information presented in the CCR.

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Appendix A. Supplementary data

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